PERSPECTIVES AND APPROACHES TO TEACHING LANGUAGE PATTERNS IN ENGLISH FOR MATHEMATICS

Vanya Ivanova, Angel Todorov, Boyan Zlatanov

Abstract. *This paper examines the specific language used in mathematics – fixed, recurring phrases that students at the Faculty of Mathematics and Informatics at the University of Plovdiv often find challenging. In understanding mathematical texts and expressing ideas in pure mathematics, precise mathematical phrasing is as important as general language proficiency. The course integrates typical mathematical expressions essential to effective English communication. These patterns, shaped by mathematical conventions, are rarely addressed explicitly in ESP courses, which can lead to learner difficulties. The study presents common examples, discusses typical errors, and suggests teaching strategies, including self-study exercises and activities based on real student mistakes. Focusing on these language patterns can make mathematical English more accessible and help students express abstract reasoning with confidence and clarity.*

Key words: Mathematical English, Language Patterns, ESP, Learner Difficulties, Practice Tests.

1. Introduction

It is well known that in understanding mathematical texts and expressing ideas in pure mathematics, specific linguistic phrasing is as important as general language proficiency. In mathematics, meaning is conveyed not only through symbols and formulas but also through precise, conventionalised expressions. In the English for Specific Purposes (ESP) course for mathematics students, we aim to integrate typical mathematical phrases and sentence patterns essential for effective communication.

In recent years, ESP's role in mathematical education has grown considerably, reflecting the need for students to access international literature, collaborate academically, and present their work in English. However, despite ESP's established place in higher education, mathematical phrasing and formulaic patterns are rarely taught explicitly. At the Faculty of Mathematics and Informatics at the University of Plovdiv, where students have solid mathematical grounding but varying English proficiency, these challenges are particularly evident. Many learners demonstrate adequate grammatical and lexical competence yet struggle with fixed expressions that convey logical relationships, precision, and generalisation – the features that give mathematical English its clarity and rigour.

The purpose of this article is to address these challenges by:

- identifying recurring language patterns in mathematical English,
- analysing learner difficulties observed in the classroom, and
- suggesting practical classroom and self-study approaches based on authentic student work.

By focusing on these recurring linguistic structures, the study seeks to make mathematical English more accessible and to support students in expressing abstract reasoning with confidence and precision.

2. Theoretical Background

In mathematical communication, language patterns and fixed expressions are word combinations that appear repeatedly to express logical connections, conditions, and stages of reasoning. These ready-made phrases give structure and clarity to mathematical argumentation. Common examples include let us assume that, it follows that, if and only if, for all values of x, and the proof consists of two parts. Such expressions are not only convenient linguistic shortcuts but also carry meaning about how ideas relate to each other – they show how reasoning unfolds step by step.

Research on formulaic language and lexical bundles in English for Specific Purposes (ESP) has demonstrated that these recurring sequences of words are crucial to fluent and appropriate communication across all disciplines [1, 15]. In ESP courses, focusing on such units helps learners use language in ways that sound natural within their specific academic field. In mathematics, however, conventional phrases in definitions, theorems, and proofs often differ from those used in general academic English, which can make comprehension and writing more difficult for students if these forms are not taught explicitly.

The mathematical register is therefore quite distinct from ordinary academic English. It relies on precision, formal logic, and consistency. Even simple words such as let, show, since, or suppose have specialised meanings in mathematical contexts. Because of this, linguistic accuracy is closely tied to conceptual clarity – a slightly incorrect expression can easily change the logical meaning of a statement.

Becoming familiar with these patterns and practising them actively helps students move from general English competence to confident use of mathematical English. It also supports clearer thinking and more precise reasoning, as mathematics, language, and logic are closely connected.

Fixed linguistic forms, or formulaic sequences, play a central role in the structure of academic discourse. Their function and pedagogical value have been examined in detail by [14] and [5], who emphasise that disciplinary writing relies on recurring phraseological units reflecting both communicative purpose and disciplinary identity. Understanding and using fixed linguistic forms appropriately is therefore a key competence for students aiming to communicate effectively in mathematical English.

The conducted research provides a connection between the specifics of the speciality and the vocabulary volume of words – including general English and specialised terms and phrases – necessary for understanding specialised mathematics texts ([2, 3, 6, 9] Table 1).

Table 1. Descriptive statistics of students' self-assessments of the four language skills

Discipline	**Approximate Vocabulary Size**	**Share of Specialised Terminology**
Mathematics	6000 – 7000	∼ 20 – 25%

In the following figure (Figure 1), we present data from an analysis that links vocabulary size to the percentage comprehension of a mathematical text.

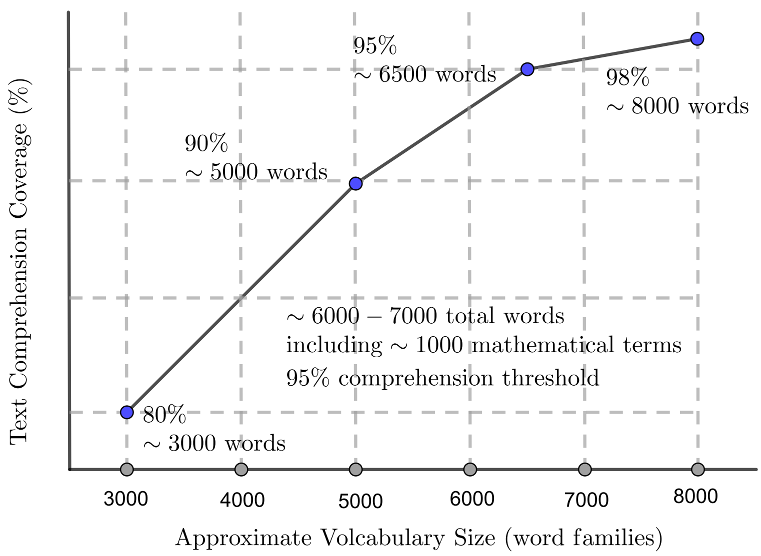

Figure 1. Relationship between vocabulary size and predicted comprehension of mathematical texts, based on vocabulary coverage thresholds (adapted from [2, 7, 3])

3. Methodological Framework

The study is based on classroom observations and written work collected from first-year Mathematics students at the Faculty of Mathematics and Informatics, University of Plovdiv. Participants represent a wide range of English proficiency levels, from A2 to C1. The teaching materials include authentic mathematical texts, definitions, and proofs used in English for Specific Purposes (ESP) classes.

The analysis focuses on recurring language patterns in mathematical English and on typical learner difficulties observed during reading and writing tasks. Examples were drawn from real student errors and reformulated to illustrate common problem areas. The approach is descriptive, aiming to identify frequent mistakes and suggest effective strategies for classroom practice and self-study.

4. Types of Language Patterns in Mathematical English

The language of mathematics relies on a set of recurring patterns that signal how ideas are introduced, connected, and justified. These formulaic expressions serve as linguistic tools that help readers follow the logical flow of definitions, proofs, and arguments. For students learning mathematical English, recognising these patterns is essential to understanding and producing coherent mathematical discourse.

Structural and Definitional Patterns Mathematical texts frequently begin with expressions used to introduce new objects or assumptions, such as *Let x be ..., Suppose that ..., or We define ... as follows.* These patterns establish the conditions under which a statement holds and frame the logical scope of a proof. Other expressions, like *Denote by ..., Fix* $\varepsilon > 0$, or *A function is said to be bounded if ...*, serve as markers of precision and convention. Students often omit or misuse these introductory phrases, replacing them with literal translations from their first language or with less formal alternatives that weaken the mathematical tone.

Logical Connectors and Relations Mathematical reasoning depends heavily on precise logical connectors that express relationships between propositions. Expressions such as if and only if, therefore, provided that, and the following are equivalent, define the logical structure of proofs. The distinction between necessity (*a necessary condition for ... is ...*) and sufficiency (*a sufficient condition for ... is ...*) is a frequent source of confusion. Students sometimes overgeneralize, using *if* where *if and only if* is required, or overlooking small but crucial differences between *is contained in*, *is included in*, and *is* *equal to.*

Inference and Proof Transitions When developing an argument, writers rely on inference markers such as *It follows that, Hence, Thus, or Consequently.* Transitional expressions like *Now we show that, From (1) we obtain*, or *As shown above* guide readers through the steps of a proof. These linking expressions are vital for making ideas clear; yet, students often use them too little, resulting in lists of statements that don't quite connect. Regular practice with such phrases helps learners organise their reasoning and keep their arguments logical and easy to follow.

Generalisation and Limitation Expressions such as *for all, for some, there exists, and without loss of generality* specify the scope of a statement. These language markers are crucial for showing exactly when a statement or example applies. Problems typically arise when students omit quantifiers or use them incorrectly, which can render their sentences unclear or even alter the logical meaning.

Proof Structure and Concluding Expressions Some expressions illustrate how a mathematical argument is constructed and brought to a conclusion. Common ones include *To prove the theorem, we first show that ...*, *We claim that ...*, and *This completes the proof.* Phrases like *Suppose, on the contrary, that ...* or *This contradicts the assumption that ...* are used in proofs by contradiction. When students don't know these expressions, they often find it hard to explain the logic of a proof clearly, even if they fully understand the math itself.

Remarks, Examples, and Quantitative Reasoning Mathematical writing also includes less formal commentary, often introduced by *Note that ...*, *Observe that ...*, or *By definition ....* Examples are introduced with *Consider the case ...* or *As an example ....* When describing quantitative relations, students encounter expressions like *as* $n \to \infty$*,* $f(x)$ *tends to* 0*, is bounded by, or approximately equals to.* These phrases help describe limits, dependencies, or approximations accurately – areas where direct translation from Bulgarian often leads to mistakes.

Overall, these patterns are at the heart of mathematical English. They follow established conventions that students need to notice, practice, and use repeatedly before they become natural. Many of the difficulties learners face come from skipping these expressions, using them too broadly, or translating them too literally from their own language. Focusing on these patterns in class - with real examples from textbooks and student work – helps learners develop a sense of how mathematical ideas are expressed clearly and logically in English.

5. Teaching Approaches

5.1. Classroom Strategies

Practical classroom work focuses on helping students notice and use key language patterns in meaningful contexts. Short awareness-raising tasks can be easily integrated into content lessons – for instance, asking students to identify expressions that mark definitions or logical transitions in a text. Error analysis activities, where learners correct anonymised examples from peers' work, are particularly effective because they show real, common mistakes. Transformation tasks can help students restate theorems or definitions using accurate mathematical English, while matching exercises encourage them to connect phrases with their logical functions, such as hypothesis, conclusion, or proof step. These focused activities promote accuracy without significantly detracting from mathematical content teaching.

5.2. Self-Study Practice Tests

The proposed teaching approach aligns with corpus-based and task-based learning traditions in English for Specific Purposes (ESP) (Nesi & Basturkmen, 2006; Simpson-Vlach & Ellis, 2010). By emphasising authentic, discipline-specific language, it encourages learners to notice and reproduce recurrent formulaic patterns in real mathematical discourse. This reflects ESP's current focus on learner autonomy and data-driven learning, where corpus exposure helps students infer expression functions from authentic use. Online self-study tests reinforce this framework by providing immediate feedback and enabling quantitative monitoring of linguistic progress. Over time, these materials could form a small-scale corpus of student mathematical writing, supporting research on how learners acquire and internalise mathematical English and how their use of formulaic expressions evolves from novice to expert levels.

To support independent learning, a series of short online tests was created using Google Forms. Each test includes mostly closed-ended items – multiple choice, gap-fill, and sentence-completion questions – designed to reinforce standard expressions. One or two open-ended tasks invite productive use of the target patterns, e.g., restating a simple theorem. Automatic feedback provides explanations and examples, allowing students to review mistakes immediately. The tests follow a spaced-repetition principle, encouraging learners to revisit key expressions throughout the course. As Petkova and Kelbecheva (2021) and Répás and Petkova (2022) note, such practice tests effectively motivate students to memorise and consolidate new linguistic material outside the classroom. Google Forms also generates useful statistics – average scores, submission numbers, and items with the lowest results – helping teachers identify expressions or structures needing further attention.

5.3. Consolidation in Class

Results from the self-study tests are discussed briefly in class, with a focus on the most frequent or interesting errors. Short review sessions and pair-work tasks give students the chance to apply the target expressions in spoken form – for instance, by explaining a short proof or example using the correct phrasing. This step closes the learning cycle by turning individual practice into active, collaborative use of mathematical English.

6. Conclusion

Focusing on the fixed patterns of mathematical English has proved to be both useful and motivating for students. Many report feeling more confident when reading or writing mathematical texts and more aware of how precise phrasing supports clear reasoning. Over time, improvement can be seen not only in accuracy but also in the fluency and structure of their written explanations.

Giving explicit attention to these recurring expressions helps bridge the gap between mathematical thinking and linguistic expression. When students understand how language works within the context of mathematical logic, they communicate ideas more effectively and with greater confidence.

Looking ahead, future studies could expand on this work by developing AI-based feedback tools capable of detecting phraseological inaccuracies in students' mathematical writing and suggesting corrections informed by corpus frequency and disciplinary norms. Another promising avenue would be to compare phraseological usage across related fields such as physics, computer science, and engineering to determine whether "mathematical English" represents a shared scientific register or a discipline-specific sublanguage. Longitudinal research may also investigate how learners' awareness of fixed expressions evolves over time and how explicit instruction affects both written and spoken performance. Integrating corpus methods, AI-supported analytics, and classroom pedagogy would thus create a dynamic, data-informed framework for teaching academic English in mathematical and technical contexts.

In summary, successful acquisition of specialised English requires the integration of all components shown in Figure 2.

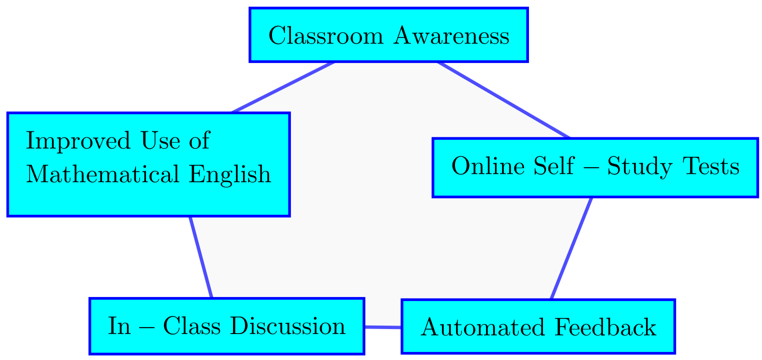

Figure 2. Components contributing to successful acquisition of specialised English in mathematics courses.

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